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United States
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Dividends From Wood Research

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Explanation and Instructions

"Dividends From Wood Research" is a semiannual listing of recent publications resulting from wood utilization research at the Forest Products Laboratory (FPL). These publications are produced to encourage and facilitate application of Forest Service research. This issue lists publications received from the printer by the FPL Publications Section between July 1, 1990, and December 31, 1990.

Each publication listed is available through at least one of the sources below. For each entry, we indicate the primary source for that publication and show you how to obtain a copy:

Available from FPL (indicated by an order number before the title of the publication): Quantities limited. Circle the number on the order blank and mail it to the FPL.

Available through sales outlets (indicated by the name of the outlet and, when available, price information): Major sales outlets are the Superintendent of Documents, the National Technical Information Service (NTIS), and various private publishers. Order directly from the outlet.

Available through libraries: Research publications are available through many public and university libraries in the United States and elsewhere. U.S. Government publications are also available through many Government Depository Libraries. Check with a major library near you to determine availability.

List of Categories

Publications are listed within the following general categories:

- Biodeterioration and Protection
- Engineering Properties and Design Criteria
- Fiber and Particle Products
- Fire Safety
- General
- Microbial and Biochemical Technology
- Mycology
- Processing of Wood Products
- Pulp, Paper, and Packaging
- Timber Requirements and Economics
- Tropical Wood Utilization
- Wood Bonding Systems

Recent Publications

July-December 1990

Biodeterioration and Protection

1. Resistance of Shakes and Shingles Made From Western Hemlock and Pacific Silver Fir to Wetting-Drying Degrade Accelerated Tests

Buchanan, Brian; De Groot, Rodney C.; Boyette, John
Forest Prod. J. 40(9): 29-34; 1990.

This study determined, if under conditions of accelerated cyclic wetting and drying, several sizes of shakes and shingles manufactured from western hemlock and Pacific silver fir, given no additional chemical treatment, were as dimensionally stable as (1) 18-in., No. 1 Grade western redcedar shingles with 3/8-in. butt thickness or (2) either heavy or medium, handsplit and resawn, 24-in. western redcedar shakes. This study also hoped to gain insight into possible long-term effects that chemical treatments might have upon shakes and shingles made from western whitewoods.

Exterior Wood Surfaces

Feist, William C.

In: Matulionis, Raymond C.; Freitag, Joan C., eds.
Preventive maintenance of buildings. New York, NY:
Van Nostrand Reinhold; 1990. Chapter 7: 183-214.

Available from Van Nostrand Reinhold, 7625 Empire Drive, Florence, KY 41042. \$41.95 each.

The primary functions of any wood finish are to protect the surface, help maintain the appearance, and provide cleanability. This chapter discusses how wood and wood-based products in a variety of species, grain patterns, textures, and colors can be effectively finished or refinished by many different methods. Also, different finishes give varying degrees of protection; therefore, the type, quality, quantity, and application method of the finish must be considered when selecting and planning the finishing or refinishing.

2. Weathering Performance of Painted Wood Pretreated With Water-Repellent Preservatives

Feist, William C.
Forest Prod. J. 40(7/8): 21-26; 1990.

This paper evaluates the long-term effect of solvent-borne and waterborne water-repellent preservative pretreatments on the performance of various paint systems applied to different wood substrates. Results were compared to those obtained with untreated substrates.

3. 80 Years of Wood Research

Feist, William C.; Williams, R. Sam
In: Am. Paint & Coating J. Conven. Daily. 75(8):
30, 31, 33; 1990.

This paper presents an overview of past, present, and future wood finishing research at the Forest Products Laboratory. The problems of the lack of research on wood finishing and the lack of research support are discussed.

4. Durability of Heartwood in Treated Southern Pine Bulkheads

Johnson, Bruce; Jackson, Roy
Forest Prod. J. 40(7/8): 41-46; 1990.

The objectives of this study were to (1) compare treatability of Virginia and loblolly/longleaf pines, (2) compare penetration ability of chromated copper arsenate and creosote, (3) determine whether pretreatment incising and longer pressure periods significantly improved preservative penetration, and (4) compare performance of chromated copper arsenate- and creosote-treated Virginia and loblolly/longleaf pines in marine exposure with and without pretreatment incising.

5. Treatability of Press-Dried Loblolly Pine 2 by 4's

Johnson, Bruce; Simpson, William; Gutzmer, David
Forest Prod. J. 40(6): 41-42; 1990.

Plantation-grown loblolly pine 2 by 4's were either kiln dried or press dried and then pressure treated with chromated copper arsenate, type C. Gain-in-weight retentions of all sapwood specimens and specimens containing up to 15 percent heartwood were compared for the two drying methods. Press drying resulted in small but statistically significant increases over kiln drying for both sapwood 2 by 4's and heartwood-containing 2 by 4's.

Measuring Retention of Chromated Copper Arsenate in Conifer Sapwood by Direct-Scan X-Ray Techniques

Smith, Susan M.; Morrell, Jeffrey J.;
Winandy, Jerrold E.
J. Wood Chem. Technol. 10(1): 21-38; 1990.

Available from Publications Office, Forest Research Laboratory, Oregon State University, Corvallis, OR 97331-5709. No charge.

This report describes how well direct-scan x-raying predicts retention and distribution of chromated copper arsenate in the sapwood of a conifer.

Engineering Properties and Design Criteria

6. Methods for Assessing Wood Structures in Place

Falk, R.H.; Ross, R.J.
In: Suprenant, Bruce S., ed. Serviceability and durability of construction materials: Proceedings of 1st materials engineering congress; 1990 August 13-15; Denver, CO. New York: American Society of Civil Engineers; 1990: 324-330. Vol. 1.

The Forest Products Laboratory is developing a comprehensive guideline for assessing the condition of existing wood structures. This paper provides an overview of the current literature on condition assessment that forms the basis of this guideline. Also described is the Forest Products Laboratory research on nondestructive testing tools.

7. Stress Class Systems—An Idea Whose Time Has Come?

Green, David W.; Kretschmann, David E.
USDA Forest Serv. Res. Pap. FPL-RP-500; 1990.
22 p.

Stress class systems are species-independent grade classification systems for structural lumber. They are used throughout the world to reduce the number of species and grade choices that face the designer of engineered wood products. Stress class systems offer an opportunity to simplify lumber specification in the United States and to encourage more uniform quality standardization across product types. This report describes the major stress class systems used in Europe and the Pacific Rim countries and discusses the advantages and disadvantages of these systems. In addition, an alternative stress class system for use in the United States is proposed. It is recommended that development of a U.S. stress class system should be a consensus effort, involving the lumber industry, user groups, and design engineers.

8. Instrumented Impactor for Testing Wood-Base Floor Panels

McNatt, J. Dobbin; Soltis, Lawrence A.
J. Test. Eval., JTEVA 18(4): 265-273; 1990.

The objectives of this study were as follows: (1) To develop a steel impactor instrumented with an accelerometer. The accelerometer determines values necessary for momentum and kinetic energy analysis, and failure may be observed and defined from accelerometer data. (2) To compare impact data obtained from tests on selected single-layer wood-base floor panels using a 14-kg steel impactor, a 27-kg steel impactor, and a 14-kg lead-shot bag. (3) To develop baseline energy levels that can be used for comparing new floor panel materials.

9. Relationships Between Small-Specimen and Large Panel Bending Tests on Structural Wood-Based Panels

McNatt, J. Dobbin; Wellwood, Robert W.; Bach, Lars
Forest Prod. J. 40(9): 10-16; 1990.

Four test methods were used to measure bending strength and stiffness of nine different structural wood-based panels. Four plywoods, four oriented strandboards, and one waferboard were evaluated by one small-specimen test and by three large-panel tests: pure moment (Post flexure), midspan-loaded machine stiffness rating, and third-point loading. The three large-panel tests yielded higher modulus of elasticity (MOE) values and lower modulus of rupture (MOR) values than the small-specimen test. Regression equations were developed that accurately predict MOR and MOE values between test methods. These equations were applicable to the nine structural wood-based panels in both the panel length and width directions.

10. Structural Wood Products

Moody, Russell; Ritter, Michael

In: Suprenant, Bruce S., ed. Serviceability and durability of construction materials: Proceedings of 1st materials engineering congress; 1990 August 13-15; Denver, CO. New York: American Society of Civil Engineers; 1990: 41-52. Vol. 1.

This paper provides a description of available structural wood products. Traditional products such as lumber and plywood are being supplemented by new products that include composite lumber and structural flakeboards. Designers now have a range of engineered wood products to choose from, including glulam timber, prefabricated trusses, and prefabricated I-joints. These new products generally are processed with some degree of reconstitution that tends to decrease variability in strength properties and improve reliability. Future trends in these products will depend upon several factors including raw material availability and processing developments.

11. Applications of Wood Materials for Innovative Bridge Systems

Moody, Russell C.; Ritter, Michael A.; GangaRao, Hota

In: Suprenant, Bruce S., ed. Serviceability and durability of construction materials. Proceedings of 1st materials engineering congress; 1990 August 13-15; Denver, CO. New York: American Society of Civil Engineers; 1990: 423-432. Vol. 1.

This paper describes the completed research and the status of research underway on timber bridges that are part of the USDA Forest Service timber bridge initiative. The initiative includes a research and technology transfer program to develop new and improved bridge systems and increase awareness of the attributes of timber bridges. Research on material properties, preservative treatments, and innovative system development is included, and programs are underway at several universities in the United States, many of which are cooperating with the Forest Products Laboratory.

Racking Behavior of Wood-Framed Gypsum Panels Under Dynamic Load

Oliva, Michael G.

Report No. UCB/EERC-8506. April 1990. 49 p.

Available from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161. \$17 each.

This report describes an experimental test program that was conducted to determine the strength, damage mechanisms, displacement limits, and stiffnesses of walls constructed of wood light-framing and sheathed with gypsum board. Nearly identical walls were tested with lateral loads applied slowly or statically, at a slow cyclical rate, and at a dynamic rate. Two groups of walls were examined: walls with the sheathing nailed to the frame, and walls with the sheathing nail-glued to the frames.

12. Permanence of Warp Reduction in Press-Dried Plantation Loblolly Pine 2 by 4's

Simpson, William T.

Forest Prod. J. 40(11/12): 51-52; 1990.

Results from a 1987 study showed that press-dried, 8-ft-long, plantation-grown loblolly pine 2 by 4's showed less warp and downgrade than kiln-dried 2 by 4's. The purpose of this study was to determine the permanence of this warp and downgrade reduction after approximately 1 year of storage. After the year of storage, the press-dried 2 by 4's still showed considerably less warp and downgrade than the kiln-dried 2 by 4's.

13. Fire-Retardant-Treated Wood: Effects of Elevated Temperature and Guidelines for Design

Winandy, Jerrold E.

Wood Design Focus. Summer: 8-10; 1990.

Fire-retardant-treated wood is an important component of nonresidential commercial and multifamily constructions. Research has shown that not all fire-retardant-treated wood exhibits similar performance attributes. Some formulations may cause thermally induced degradation of the wood in service. This paper briefly discusses the causes of the strength reductions and presents tentative guidelines for using fire-retardant-treated lumber and plywood.

14. Protection of Wood Designs in Adverse Environments

Winandy, J.E.; Morrell, J.J.

In: Suprenant, Bruce S., ed. Serviceability and durability of construction materials: Proceedings of 1st materials engineering congress; 1990 August 13-15; Denver, CO. New York: American Society of Civil Engineers; 1990: 303-313. Vol. 1.

Engineers and architects are becoming increasingly aware of the risks of poor wood design practices and the benefits of using wood properly. This paper addresses biological factors that influence the risk portion of the risk-benefit equation. It further suggests appropriate methods to prevent designed-in failure through the use and specification of wood preservatives accepted by the U.S. Environmental Protection Agency.

15. Metal-Plate Connections Loaded in Combined Bending and Tension

Wolfe, Ronald W.

Forest Prod. J. 40(9): 17-23; 1990.

This study evaluates the load capacity of metal-plate connections under combined bending and axial loads and shows the reduction in connection tensile capacity with an increase in applied moment. Five load categories, including pure axial tension, pure bending, and three intermediate levels of combined loading, were applied to joints fabricated using one plate type in Southern Pine lumber. Each joint was tested to failure and the axial and/or moment load at the connection was evaluated on the basis of its fraction of pure axial and/or moment capacity. A tension-bending interaction equation was derived to represent the observed interaction response of these connections.

16. Empirical Failure Criteria With Correlated Resistance Variables

Zahn, John J.
J. Struct. Eng. 116(11): 3122-3137; 1990.

When a member is subjected to combined loading, such as combined bending and compression, the failure criterion contains more than one resistance variable. This paper addresses the practical effects of correlation among those resistance variables, both during the experimental inference of the failure criterion itself and during subsequent reliability analyses that employ it.

Fiber and Particle Products

17. Strength Properties of Optimally Designed Rectangular Composite Wood Joists

Geimer, Robert L.; Laufenberg, Theodore L.
Forest Prod. J. 40(7/8): 7-14; 1990.

The objectives of this study were to experimentally evaluate the strength and stiffness properties of composite wood joists whose flange and web components were designed and fabricated to provide (a) optimum stiffness-to-weight ratios and (b) bending stiffness equivalent to that of solid-sawn lumber. In addition, forming and pressing techniques suitable for the manufacture of composite wood joists were explored.

18. Fiber Recovery Economics for Secondary Fiber Mills

Marin, Thomas C.; Klungness, John H.
In: TAPPI Proceedings, 1989 Pulping conference;
1989 October 22-25; Seattle, WA. Atlanta, GA:
TAPPI Press; 171-176. Book 1.

This paper examines the economic feasibility of using disk separation to remove contaminants and recover fiber from mill tailings of secondary newsprint mills.

19. Acetylation and the Development of New Products From Radiata Pine

Plackett, D.V.; Rowell, R.M.; Close, E.A.
In: Burton, R.J.; Tarlton, G.L., eds. Proceedings
of the composite wood products symposium; 1988
November 9-10; Rotorua, New Zealand. New Zealand:
Forest Research Institute: 68-72; 1990. FRI Bulletin
No. 153.

This study demonstrated that there was no difference in reactivity of pine sapwood or heartwood flakes during acetylation using acetic anhydride. Flakeboards made from acetylated sapwood or heartwood flakes performed similarly on exposure to water or high relative humidity. Acetylated flakeboards swelled much more slowly and to a lesser extent in water and in humidity tests than untreated control boards.

20. Chemical Modification of Lignocellulosic Fibers to Produce High-Performance Composites

Rowell, Roger M.
In: Glass, J. Edward; Swift, Graham, eds. Agricultural and synthetic polymers—Biodegradability and

utilization. ACS symposium series 433. American Chemical Society 197th national meeting; 1989 April 9-14; Dallas, TX. Washington, DC: American Chemical Society; 1990. Chapter 21.

The performance properties of composites made from wood and other lignocellulosic materials can be greatly improved by changing the basic chemistry of the cell wall polymers. This paper reviews published research on reducing dimensional instability and susceptibility to degradation by biological organisms, heat, and ultraviolet radiation to produce high-performance lignocellulosic composites based on acetylation of the furnish before product formation.

21. Chemical Modification of Wood—Its Application to Composite Wood Products

Rowell, R.M.
In: Burton, R.J.; Tarlton, G.L., eds. Proceedings
of the composite wood products symposium: 1988
November 9-10; Rotorua, New Zealand. New Zealand:
Forest Research Institute: 57-67; 1990. FRI Bulletin
No. 153.

This paper reviews one technological approach that will protect wood composites in an outdoor environment. It also discusses wood as a composite, the mechanisms of wood degradation, potentials of using chemical modification technology for protection, a brief description of one modification system, improvement in wood furnish properties using this modification system, and some potential uses for the technology, costs, and considerations for future developments.

22. Acetyl Balance for the Acetylation of Wood Particles by a Simplified Procedure

Rowell, Roger M.; Simonson, Rune; Tillman,
Anne-Marie
Holzforschung. 44(4): 263-269; 1990.

The effects of several reaction conditions were investigated and the acetyl balance was determined for the acetylation of wood particles according to a simplified acetylation procedure. The procedure consisted of dipping the wood particles in acetic anhydride for a short time, followed by a drainage step, and reaction at an elevated temperature, followed by removal of excess and byproduct chemicals by means of evacuation.

23. Correcting for Instrumentation With Corrugated Fiberboard Edgewise Crush Test Theory

Urbanik, Thomas J.
Tappi J. October: 263-268; 1990.

A theory of corrugated fiberboard short column failure by buckling is incorporated within a semiempirical model that further accounts for postbuckling behavior. A theory of metal postbuckling failure is applied to paper to specifically derive a set of postbuckling constants, θ_0 , θ_1 , θ_2 . Values for these constants differ with each user's unique testing methods, but the constants can be used to correct for instrumentation differences. A set of equations results in a form that can be used to predict the elastic, inelastic, or combined failure modes and can thereby confirm or refute the accuracy of the test methods. Software

based on this theory is being developed for use by packaging engineers. It is intended as easy-to-use software for determining the optimum design of corrugated containers.

24. Force Plate for Corrugated Container Vibration Tests

Urbanik, Thomas J.

J. Test. Eval., JTEVA. 18(5): 359-362; 1990.

The design and application of a force plate for stacked container vibration tests are described in this paper. The force plate can be used to determine the generalized single-degree-of-freedom properties of a multiple-degree-of-freedom system.

25. Reconstituted and Treated Products

Youngquist, John

In: Opportunities for harvesting and wood products engineering research: Proceedings of the CANFOR symposium; 1989 October 19-20; Vancouver, B.C., Canada. Vancouver, B.C., Canada: University of British Columbia; 1990: 59-75.

This paper reviews the development of composites from a historical perspective and some of the significant innovations and trends that have occurred or that are currently occurring. It discusses likely changes that may occur in the composites industry as well as future product and marketing trends for the wood composites industry.

26. Mechanical and Physical Properties of Wood/Plastic Fiber Composites Made With Air-Formed Dry-Process Technology

Youngquist, John A.; Muehl, James; Krzysik, Andrzej; Xin, Tu

In: Wang, S.Y.; Tang, R.C., eds. Proceedings, 1990 joint international conference on processing and utilization of low-grade hardwoods and international trade of forest-related products; 1990 June 11-13; Taiwan. Taiwan: National Taiwan University; 1990: 159-162.

This paper reports the effect of species, composition ratio, and formulation on the mechanical and dimensional stability properties of wood-plastic composites made with air-forming technology. Panels made with yellow cypress fibers had higher strength properties and dimensional stability than panels made with hemlock fibers. Decreasing the ratio of yellow cypress to polypropylene fibers from 90/10 to 70/30 increased all the properties measured. For all properties except impact energy, panels made with the hemlock/polyester formulation had higher properties than panels made with the hemlock/polypropylene or hemlock/polyester/phenolic resin formulations. By contrast, panels made with the hemlock/polyester/phenolic resin formulation had the highest impact energy values.

27. Effects of Steam and Acetylated Fiber Treatment, Resin Content, and Wax on the Properties of Dry-Process Hemlock Hardboards

Youngquist, John A.; Rowell, Roger; Ross, Nancy; Krzysik, Andrzej M.; Chow, Poo

In: Wang, S.Y.; Tang, R.C., eds. Proceedings, 1990 joint international conference on processing and utilization of low-grade hardwoods and international trade of forest-related products; 1990 June 11-13; Taiwan. Taiwan: National Taiwan University; 1990: 253-257.

This paper reports the physical and mechanical properties of steam-pretreated or acetylated western hemlock dry-process hardboards prepared with two levels of resin and wax contents. Both heat pretreatment and acetylation improved dimensional stability. Properties measured included modulus of elasticity, modulus of rupture, tensile strength parallel to and perpendicular to board surface, thickness swell, water absorption, and linear expansion. Both 24-h water-soak and 2-h water-boil tests were conducted to determine the potential use of dry-process hardboards as structural components under high moisture content conditions.

Fire Safety

28. Effects of Fire Retardant Chemicals on the Bending Properties of Wood at Elevated Temperatures

LeVan, Susan L.; Ross, Robert J.; Winandy, Jerrold E.

USDA Forest Serv. Res. Pap. FPL-RP-498; 1990. 24 p.

This paper reports the results that show how the effectiveness of acidic fire retardant chemicals rests on achieving a delicate balance between reducing the flammability of the wood and maintaining strength properties.

29. Modifications to an Ohio State University Apparatus and Comparison With Cone Calorimeter Results

Tran, H.C.

In: Quintiere, J.G.; Cooper, L.Y., eds. Heat and mass transfer in fires: Proceedings of the AIAA/ASME thermophysics and heat transfer conference; 1990 June 18-20; Seattle, WA. New York: The American Society of Mechanical Engineers; 1990: 131-139. Vol. 141.

An Ohio State University (OSU) heat release apparatus was modified to obtain piloted ignition data and heat release rate using the oxygen consumption method. To monitor deviation from the baseline heat flux to the sample during a test, an auxiliary heat flux meter was added to the OSU apparatus. The heat flux measured was the incident flux from the radiant panel and did not include flame flux. To obtain time to ignition, the gas phase was ignited with a pilot above the specimen. Six wood materials used in a series of room fire tests were tested at three different heating flux levels.

30. Fire Endurance Research at the Forest Products Laboratory

White, Robert H.

Wood Design Focus. Summer: 5-7; 1990.

Fire endurance research activities and facilities at the Forest Products Laboratory (FPL) concern the ability of a wood member or assembly to withstand the effects of fire while acting as a fire barrier and supporting a load. Fire

endurance is generally concerned with the post-flashover portion of the fire. The importance of fire endurance in fire safety is reflected in building code requirements for fire resistance ratings for building elements. This paper discusses how the FPL fire endurance research program is oriented largely toward supporting (1) the increased use of wood in commercial and multifamily buildings where fire-rated assemblies are required by building codes and (2) the use of new structural wood components. Experience has shown that new wood engineering technologies can conflict with current levels of fire safety.

General

31. Overview of Moisture-Related Damage in One Group of Wisconsin Manufactured Homes

Ten Wolde, A.

In: ASHRAE Transactions. 95(1): 405-414; 1989.

In July 1986, reports surfaced of widespread moisture damage in walls of manufactured single-family homes in Wisconsin. The homes were manufactured by a company that declared bankruptcy and was liquidated just before the reports of moisture damage surfaced. This paper presents information about the nature and extent of the damage and summarizes the results of a health study of residents of the homes and air quality measurements of the homes.

Microbial and Biochemical Technology

32. Selective Medium for Isolating *Phanerochaete chrysosporium* From Soil

Dietrich, Diane M.; Lamar, Richard T.

Appl. Environ. Microbiol. October: 3088-3092; 1990.

A selective medium was developed that is capable of isolating *Phanerochaete chrysosporium* from soil. This medium contains 15 ppm of benomyl ($15 \mu\text{g g}^{-1}$) and 550 ppm of streptomycin sulfate in 2 percent malt agar and is held at 30°C after inoculation. *P. chrysosporium* was isolated from three nonsterile forest soils to which the fungus had been added. These soils contained large microbial populations.

Characteristics and N-Terminal Amino Acid Sequence of a Manganese Peroxidase Purified From *Lentinula Edodes* Cultures Grown on a Commercial Wood Substrate

Forrester, Ian T.; Grabski, Anthony C.; Mishra, Chittra; Kelley, Brian D.; Strickland, W. Nick; Leatham, Gary F.; Burgess, Richard R.

Appl. Microbiol. Biotechnol. 33: 359-365; 1990.

Available from Protein Purification Facility, University of Wisconsin Biotechnology Center, Madison, WI 53705. No charge.

This paper reports the isolation, purification, N-terminal amino acid sequence, and characteristics of MnP1.

33. Mineralization of the Methoxyl Carbon of Isolated Lignin by Brown-Rot Fungi Under Solid Substrate Conditions

Jin, L.; Nicholas, D.D.; Kirk, T.K.

Wood Sci. Technol. 24: 263-276; 1990.

The objective of this work was to begin developing an experimental system for studying brown-rot demethylation of lignin. First, several fungi were screened for their ability to mineralize the methoxyl carbon of lignin (i.e., to convert [methoxyl]- ^{14}C -lignin to $^{14}\text{CO}_2$). Using research experience gained with white-rot fungi as a guide, the influences of selected culture parameters on this mineralization were then evaluated. A solid wood substrate was added to methoxyl-labeled lignin.

34. Comparison of Lignin Peroxidase, Horse-radish Peroxidase and Laccase in the Oxidation of Methoxybenzenes

Kersten, Philip J.; Kalyanaraman, B.; Hammel, Kenneth E.; Reinhammar, Bengt; Kirk, T. Kent

Biochem. J. 268: 475-480; 1990.

Lignin peroxidase oxidizes nonphenolic substrates by one electron to give aryl-cation-radical intermediates, which react further to give a variety of products. This study investigated the possibility that other peroxidative and oxidative enzymes known to catalyze one-electron oxidations may also oxidize nonphenolics to cation-radical intermediates and that this ability is related to the redox potential of the substrate.

35. Lignin Peroxidase From Fungi: *Phanerochaete chrysosporium*

Kirk, T. Kent; Tien, Ming; Kersten, Philip J.; Kalyanaraman, B.; Hammel, Kenneth E.; Farrell, Roberta L.

In: Lidstrom, Mary E., ed. Methods in enzymology. Vol. 188. Hydrocarbons and Methylotrophy. San Diego, CA: Academic Press, Inc.; 1990: 159-171. Chapter 27.

Lignin peroxidase of *Phanerochaete chrysosporium* can be produced and purified relatively easily. This paper describes production and separation of six isoenzymes, using a commonly studied wild-type strain. The fungus is grown on a chemically defined nitrogen-limiting medium in stationary or agitated flasks, the extracellular broth containing the lignin peroxidases is concentrated, and the isoenzymes are separated and purified by anion-exchange chromatography. The isoenzymes have similar physical and catalytic properties but somewhat different kinetic properties. They are encoded at least in part by different structural genes. Lignin peroxidases, in the presence of H_2O_2 , oxidize their aromatic substrates by one electron to cation radicals, which undergo diverse reactions of ionic and radical nature. Purification and characterization of lignin peroxidases from other lignin-degrading fungi are also reported.

36. In Situ Depletion of Pentachlorophenol From Contaminated Soil by *Phanerochaete Spp.*

Lamar, Richard T.; Dietrich, Diane M.

Appl. Environ. Microbiol. October: 3093-3100; 1990.

The primary objective of this study was to determine, under field conditions, the ability of two white-rot basidiomycetes to deplete pentachlorophenol (PCP) from the upper 30 cm of the contaminated soil. Pentachloroanisole (PCA) was also quantified since both *P. chrysosporium* and *P. sordida* are known to methylate PCP to PCA. This paper reports on the effects of inoculating the contaminated soil with either of the two fungi on the concentration of PCP and PCA and on survival of the fungi during a 6.5-week period.

37. Fate of Pentachlorophenol (PCP) in Sterile Soils Inoculated With the White-Rot Basidiomycete *Phanerochaete chrysosporium*: Mineralization, Volatilization and Depletion of PCP

Lamar, Richard T.; Glaser, John A.; Kirk, T. Kent
Soil Biol. Biochem. 22(4): 433-440; 1990.

The fate of pentachlorophenol (PCP) in three sterile soils inoculated with a white-rot basidiomycete, *Phanerochaete chrysosporium*, was investigated. Mineralization and volatilization of PCP and its transformation products and residual PCP concentration were measured for 2 months from soil microcosms inoculated with *P. chrysosporium* or left noninoculated.

38. Characterization of a Major Xylanase Purified From *Lentinula edodes* Cultures Grown on a Commercial Solid Lignocellulosic Substrate

Mishra, Chittra; Forrester, Ian T.; Kelley, Brian D.; Burgess, Richard R.; Leatham, Gary F.

Appl. Microbiol. Biotechnol. 33: 226-232; 1990.

This article describes the isolation and partial characterization of the major β -(1,4)-D-xylanase produced by *L. edodes* cultures grown on a commercial oak wood medium. The authors believe this is the first report of a xylanase characterized from a solid-substrate conversion process utilizing wood.

39. Mineralization of ^{14}C -Ring-Labeled Synthetic Lignin Correlates With the Production of Lignin Peroxidase, not of Manganese Peroxidase or Laccase

Perez, Juana; Jeffries, Thomas W.

Appl. Environ. Microbiol. June: 1806-1812; 1990.

Recently, Mn(II) has been shown to induce manganese peroxidases (MnPs) and repress lignin peroxidases (LiPs) in defined liquid cultures of several white-rot organisms. This paper reports that laccase is also regulated by Mn(II). Therefore, Mn(II) was used to regulate production of LiP, MnP, and laccase activities while determining the effects of Mn(II) on mineralization of ring-labeled synthetic lignin.

40. Lignin Peroxidase Oxidation of Mn^{2+} in the Presence of Veratryl Alcohol, Malonic or Oxalic Acid, and Oxygen

Popp, Janet L.; Kalyanaraman, B.; Kirk, T. Kent
Biochem. 29(46): 10475-10480; 1990.

Veratryl alcohol (3,4-dimethoxybenzyl alcohol) appears to have multiple roles in lignin degradation by *Phanerochaete chrysosporium*. It is synthesized de novo by the fungus. It apparently induces expression of lignin peroxidase (LiP), and it protects LiP from inactivation by H_2O_2 . In addition, veratryl alcohol has been shown to potentiate LiP oxidation of compounds that are not good LiP substrates. This paper presents results that indicate that LiP can indirectly oxidize Mn^{2+} and that veratryl alcohol is probably a radical mediator in this system.

41. The Promoter of the Glucoamylase-Encoding Gene of *Aspergillus niger* Functions in *Ustilago maydis*

Smith, Timothy L.; Gaskell, Jill; Berka, Randy M.; Yang, Maria; Henner, Dennis J.; Cullen, Daniel
Gene. 88: 259-262; 1990.

Promoter sequences from the *Aspergillus niger* glucoamylase-encoding gene (*glaA*) were linked to the bacterial hygromycin (Hy) phosphotransferase-encoding gene (*hph*) and this chimeric marker was used to select Hy-resistant (Hy^R) *Ustilago maydis* transformants. This is an example of an Ascomycete promoter functioning in a Basidiomycete. Hy^R transformants varied with respect to copy number of integrated vector, mitotic stability, and tolerance to Hy. Only 216 bp of *glaA* promoter sequence is required for expression in *U. maydis*, but this promoter is not induced by starch as it is in *Aspergillus* spp. The transcriptional start points are the same in *U. maydis* and *A. niger*.

Mycology

42. Serological Differentiation of Three Species of *Armillaria* and *Lentinula edodes* by Enzyme-Linked Immunosorbent Assay Using Immunized Chickens as a Source of Antibodies

Burdssall, Harold H.; Banik, Mark; Cook, Mark E.
Mycologia. 82(4): 415-423; 1990.

Antibodies to three isolates each of *Armillaria mellea*, *A. ostoyae*, *A. tabescens*, and *Lentinula edodes* were isolated from eggs of immunized laying hens. The reactivity of each antibody preparation with all isolates was examined using an enzyme-linked immunosorbent assay (ELISA). The cross-reactivity of the antibody preparations to a given *Armillaria* species varied considerably when tested against isolates of other *Armillaria* species. Several antibody preparations were capable of distinguishing isolates of its homologous species from isolates of heterologous species. The specificity of the antibodies present in eggs was dependent on time elapsed since immunization. Eggs laid 3 weeks after immunization with an *Armillaria* species isolate possessed antibodies that were most specific for isolates of that species. The intergeneric cross-reactivity was found to be smallest with antibodies from eggs laid 3 weeks or more after immunization. Preliminary results suggest that ELISA using chicken egg yolk antibodies will provide useful information in the taxonomy of *Armillaria*.

43. *Lindtneria panphyliensis* Sp. Nov. From Po Valley, Italy

Larsen, Michael J.; Bernicchia, Anarosa
Mycotaxon. 37: 349-352; 1990.

While investigating the mycological flora of Panfilia Forest in Po Valley, Italy, Anarosa Bernicchia made several collections of an undescribed species of *Lindtneria*. This paper names and describes this species of *Lindtneria*.

Cultural Studies and Identification of Wood-Inhabiting Corticiaceae and Selected Hymenomycetes From North America

Nakasone, Karen K.

Mycologia Memoir No. 15; 1990. 412 p.

Available from Lubrecht and Cramer, P.O. Box 244, Forestburgh, NY 12777. \$105 each.

In this book, cultural descriptions of 277 wood-inhabiting basidiomycetes are presented of which 85 species are described in culture for the first time. Eleven new combinations are proposed: *Acanthophysium weiri*, *Corticium appalachiensis*, *C. cremeoalbidum*, *C. efbulatum*, *C. floridense*, *C. mississippiense*, *Grandinia lanata*, *Hyphoderma albicans*, *Phlebia setulosa*, *Resinicium fuscurellum*, and *R. meridionale*. In addition, the incompatibility system of 15 species is determined. Tetrapol or bifactorial incompatibility system is reported for *Cystostereum pinicanadense*, *Cytidiella melzeri*, *Dendrothele microspora*, and *Hypochnicium lundellii*. Eleven species were found to be bipolar or unifactorial: *Cristinia sonorae*, *Hyphoderma albicans*, *H. litschaueri*, *Grandinia microsporella*, *Phlebia albida*, *P. centrifuga*, *P. queletii*, *P. setulosa*, *P. vinosa*, *Sistotrema raduloides*, and *Sistotremastrum niveocremeum*. A modified Nobles species codes system is included.

44. Taxonomic Study of *Veluticeps* (Aphyllophorales)

Nakasone, Karen K.

Mycologia. 82(5): 622-641; 1990.

Veluticeps is emended to include *Columnocystis*. New combinations of *V. fimbriata* and *V. fusipora* are proposed. Descriptions of seven species of *Veluticeps* are included as well as cultural descriptions of *V. abietina* and *V. fimbriata*. *Veluticeps fimbriata*, common throughout western North America, is a distinct species from *V. abietina*, which is found primarily in eastern and northwestern North America and Europe. A key to the species of *Veluticeps* is provided. The Chaetodermataceae is emended to include *Veluticeps* and *Crustoderma*.

Processing of Wood Products

45. Sorting Aspen Bolts and Drying Aspen Flitches for SDR

Boone, R. Sidney

In: Adams, Roy D., ed. Proceedings, aspen symposium '89: 1989 July 25-27; Duluth, MN. Gen. Tech. Rep. NC-140. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1990: 295-299.

This paper discusses the necessity of log sorting when processing aspen saw-dry-rip (SDR) to select optimum

log diameter and to minimize number of logs with dark-colored centers.

46. Lumber Drying in a Medium With Variable Potentials

Liu, J.Y.

In: Vafai, K., et al., eds. General papers: Phase change and convective heat transfer: Proceedings, AIAA/ASME thermophysics and heat transfer conference; 1990 June 18-20; Seattle, WA. New York: The American Society of Mechanical Engineers; 1990: 149-156. HTD-Vol. 129.

This paper presents an application of the Luikov system of heat and mass transfer equations for porous media to predict the temperature and moisture distributions in lumber during drying.

47. Structural Lumber From Aspen: Using the Saw-Dry-Rip (SDR) Process

Maeglin, Robert R.

In: Adams, Roy D., ed. Proceedings, aspen symposium '89: 1989 July 25-27; Duluth, MN. Gen. Tech. Rep. NC-140. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1990: 283-293.

Low-density and medium-density hardwoods such as aspen have not been used for structural lumber because conventional processing resulted in excessive warp. The USDA Forest Service has developed a process called Saw-Dry-Rip (SDR) to overcome the warp problem in hardwoods. A simple and practical way of utilizing the abundant hardwood resource, SDR, as the name implies, is sawing fitches, drying them, and then ripping them to desired widths. The small logs are live sawn (through and through on one plane), dried, and ripped. This paper describes the process and successes in research.

48. Correlation of Loblolly Pine Drying Rates at High Temperature

Milota, Michael R.; Tscherneitz, John L.
Wood Fiber Sci. 22(3): 298-313; 1990.

A correlation of drying rates based on the physics of drying has been developed for plantation-grown loblolly pine at high temperatures. Flat-sawn boards in three thicknesses were studied. At high moisture content, heat transfer is the controlling mechanism, and the predicted drying rate is a function of the air velocity and wet-bulb depression. At low moisture content, the predicted drying rate is a function of the dry-bulb temperature and the moisture content. No systematic variation in drying rate could be attributed to juvenile wood, rings per inch, or the presence of knots. The correlation is valid as dry-bulb temperatures from 180° to 270°F, wet-bulb temperatures from 140° to 200°F, and air velocities from 700 to 1,900 ft/min. This correlation can be used for modeling the effect of kiln operating parameters on the final moisture content variation and temperature drop across the load.

49. Perpendicular-To-Grain Rheological Behavior of Loblolly Pine in Press Drying

Tang, Yifu; Simpson, William T.
Wood Fiber Sci. 22(3): 326-342; 1990.

To predict the thickness loss of loblolly pine lumber during press drying, a model was developed to describe the perpendicular-to-grain rheological behavior as a function of pressure, temperature, and drying time. The strain-time curve was divided into four parts—initial elastic deformation, viscoelastic deformation, final elastic springback, and time-dependent springback—according to the characteristic responses of these behaviors to pressure, temperature, and drying time. The model was fitted to experimental data by nonlinear regression. Good agreement was obtained between the predicted and experimental thickness loss during press drying.

Pulp, Paper, and Packaging

50. Effect of Moisture and Temperature on the Mechanical Properties of Paper

Caulfield, D.
In: Perkins, R.W.; Mark, R.E.; Thorpe, J.L., eds.
Solid mechanics advances in paper related industries:
Proceedings, National Science Foundation workshop;
1989 August 13-15; Syracuse, NY. Syracuse, NY:
Syracuse University; 1990: 50-62.

The separate and combined effects of moisture, temperature, and stress—all as functions of time—control the rheological behavior of paper by causing changes in both molecular interactions and structure. To understand more fully the physics of the phenomena involved, this paper discusses the nature of the molecular interactions and fiber structural features that control the various rheological characteristics of paper.

51. Distinguishing Characteristics of Biomechanical Pulp

Sachs, Irving B.; Leatham, Gary F.; Myers, Gary C.;
Wegner, Theodore H.
Tappi J. September: 249-254; 1990.

The objective of this research was to determine the characteristics of pretreated biomechanical pulp (BMP). Using scanning electron microscopy, we compared BMP fiber and handsheets to aspen pulps and handsheets made by conventional pulping methods.

52. Recycling Wood Fiber in Municipal Solid Wastes: Opportunity for Government-Industry Partnership

Setterholm, Vance
In: Proceedings, 1990 TAPPI pulping conference;
1990 October 14-17; Toronto, ON, Canada. Atlanta,
GA: TAPPI Press; 1990: 2-5. Book 1.

This paper is a discussion of recycling municipal solid wastes from the forest products industry, namely wood and paper products that are now headed for our Nation's decreasing number of landfills. Several high-priority research needs that would provide the technical capability for a variety of valuable products are identified, and a list of the benefits of recycling wastepaper and waste wood is given.

Timber Requirements and Economics

53. Monitoring Changing Demands on Global Natural Resources

McKeever, David B.
In: Lund, H. Gyde; Preto, Giovanni, coordinators.
Global natural resource monitoring and assessments:
Preparing for the 21st century: Proceedings of the international conference and workshop; 1989 September 24-30; Venice, Italy. Bethesda, MD: American Society for Photogrammetry and Remote Sensing; 1990: 1022-1035.

The wise use of the world's forest resources to satisfy present and future needs of an ever-increasing world population is ultimately the goal of all resource management activities. Understanding and monitoring both the supply of and demand for natural resources are essential in meeting the objectives as world resource managers. This paper reviews past and present demand estimates in the United States for forest resources, the methods used to develop these demand estimates, and their associated statistical reliability.

54. Understanding the Adoption of New Technology in the Forest Products Industry

Rosenberg, Nathan; Ince, Peter; Skog, Kenneth;
Plantinga, Andrew.
Forest Prod. J. 40(10): 15-22; 1990.

This paper addresses some of the principal and unique influences on technological change in the forest products industry that must be understood to anticipate future rates of adoption of new technology and if these influences currently elicit appropriate rates of technology adoption.

55. Aspen Wood Products Utilization: Impact of the Lake States Composites Industry

Youngquist, John A.; Spelter, Henry
In: Adams, Roy D., ed. Proceedings, aspen symposium '89; 1989 July 25-27; Duluth, MN. Gen. Tech. Rep. NC-140. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1990: 91-102.

The utilization of Lake States aspen for value-added products has increased dramatically in the past 15 to 18 years. This paper reviews aspen utilization for solid and composite wood products since 1970, discusses the future demand for wood-based composites, and reviews research that may influence future utilization of aspen in the Lake States.

Tropical Wood Utilization

56. Bibliography of FPL Tropical Forest Utilization Research—1910 to 1989

Boone, R. Sidney; Gjovik, Lee R.; Harpole, George B.; Laundrie, James F.; Maeglin, Robert R.; Wolfe, Ronald W.
USDA Forest Serv. Gen. Tech. Rep. FPL-GTR-66; 1990. 30 p.

This bibliography lists published and unpublished reports generated by the USDA Forest Service, Forest Products Laboratory, between 1910 and 1989 relating to the use of tropical timber.

57. Structural Plywood From Malaysian Hardwoods

Khaidzir, Mohamad Omar; Youngquist, John A. In: Youngs, R.L., coordinator. Proceedings, 19th IUFRO world congress, division 5; 1990 August 5-11; Montreal, Canada. Montreal, Canada: International Union of Forest Research Organizations; 1990: 263-274.

Twenty-two Malaysian tropical hardwood species have been categorized into two major structural groups called the Structural I and Structural II based upon specific gravity. Structural II is further divided into Structural IIA and IIB. Species having the lowest modulus of elasticity in each group or subgroup are chosen and tested for their mechanical properties. Strength values of each chosen species conservatively represent the strength values of each particular group or subgroup. Preliminary tests on Keruing (*Dipterocarpus spp.*) and Mermawa (*Anisoptera spp.*) show that plywoods produced from Malaysian hardwoods are comparable in strength to those plywoods from the United States, Canada, and the Scandinavian countries. This paper presents partial results of a large-scale research program to assist in the drawing up of the Malaysian standard for structural plywood.

58. Composites as a Way to Add Value to the Timber Resource

McKeever, David B. In: Youngs, R.L., coordinator. Proceedings, 19th IUFRO world congress, division 5; 1990 August 5-11; Montreal, Canada. Montreal, Canada: International Union of Forest Research Organizations; 1990: 288-298.

Many local, regional, and national economies are dependent on the forest resource for a substantial amount of income and employment. However, too often the timber resource is harvested and exported without capturing the economic benefits obtainable from further processing, which adds value to the product. This paper presents a method of ranking the relative contribution of major primary timber processing operations to the economy.

Wood Bonding Systems

59. How Overdrying Wood Reduces its Bonding to Phenol-Formaldehyde Adhesives: A Critical Review of the Literature. Part I. Physical Responses

Christiansen, Alfred W. Wood and Fiber Sci. 22(4): 441-459; 1990.

This review critically evaluates literature on the ways in which excessive drying (overdrying) inactivates wood surfaces to bonding, primarily for phenolic adhesives. In Part I of a two-part review, three inactivation mechanisms involving physical responses to overdrying are considered: (1) exudation of extractives to the surface, which lowers the wettability or hides the surface, (2) reorientation

of wood surface molecules, which reduces wettability or places for bonding, and (3) irreversible closure of large micropores in cell walls.

60. Adhesion of Phenol-Formaldehyde Resin to Waterborne Emulsion Preservatives in Aspen Veneer

Vick, Charles B. Forest Prod. J. 40(11/12): 25-30; 1990.

This study is a part of a continuing effort at the Forest Products Laboratory to find waterborne preservatives that will not interfere with the bonding of adhesives to treated wood. The long-range objective is to develop an in-line process for treating and bonding of veneers, flakes, and fibers into highly durable composite panel products that can be manufactured with low capital investment in treating equipment. The objectives of this study were to determine (1) the strength and durability of phenol-formaldehyde bonds to aspen veneers treated with emulsion preservatives and (2) how preservative retention level and closed assembly time affected adhesion.

61. Adhesive Bonding of Acetylated Wood

Vick, C.B.; Rowell, R.M. Int. J. Adhesion and Adhesives 10(4): 263-272; 1990. Eighteen thermoplastic and thermosetting adhesives, including emulsion polymerisocyanates, polyurethane, moisture-curing hot-melt polyvinyl acetates, neoprene and waterborne contacts, casein, epoxy, melamine, urea, resorcinol, phenol-resorcinols, and phenolics, were tested for their adhesion to yellow-poplar wood acetylated to 0, 8, 14, and 20 weight percent gains. Effectiveness of adhesion was determined by measuring shear strength and wood failure in a dry condition and after saturation with water.

62. Adhesive Bonding of Acetylated Aspen Flakes. Part 3. Adhesion With Isocyanates

Youngquist, J.A.; Rowell, R.M. Int. J. Adhesion and Adhesives 10(4): 273-276; 1990.

The purpose of this research was to (1) investigate the use of an isocyanate adhesive, (2) determine the rate and extent of thickness swelling in liquid water and water vapor using both isocyanate and phenolic resins in control and acetylated flakeboards, and (3) determine the strength properties of isocyanate-bonded control and acetylated flakeboards.

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